



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B60C 23/04		A1	(11) International Publication Number: WO 98/34799 (43) International Publication Date: 13 August 1998 (13.08.98)
<p>(21) International Application Number: PCT/GB98/00358</p> <p>(22) International Filing Date: 5 February 1998 (05.02.98)</p> <p>(30) Priority Data: 9702295.8 5 February 1997 (05.02.97) GB</p> <p>(71) Applicant (for all designated States except US): VEHICLE SENSOR SYSTEMS LIMITED [GB/GB]; Nutwood, Burgh Hill, Etchingham, East Sussex TN19 7PB (GB).</p> <p>(72) Inventor; and</p> <p>(75) Inventor/Applicant (for US only): OWENS, David, Caradoc [GB/GB]; Nutwood, Burgh Hill, Etchingham, East Sussex TN19 7PB (GB).</p> <p>(74) Agent: ROBSON, Aidan, John; Reddie & Grose, 16 Theobalds Road, London WC1X 8PL (GB).</p>		<p>(81) Designated States: CA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>	
<p>(54) Title: TYRE PRESSURE WARNING SYSTEM</p> <p>(57) Abstract</p> <p>A tyre pressure monitoring system for a vehicle that has a plurality of sensor/transmitter units (2, 4) one for each tyre of the vehicle. Each sensor/transmitter unit has a pressure transducer (2) and a processor (14). The processor (14) compares a current pressure signal from the transducer with a pressure signal stored in its memory which corresponds to the pressure first encountered on installation of the transducer. The processor (14) includes means to transmit a fault signal when the current pressure signal differs from the stored pressure signal by more than a predetermined amount. A control unit (6) receives fault signals from the transducers and includes means (24) for indicating that a fault has occurred.</p>			
<pre> graph TD DP[DATA PROCESSING UNIT] --> S1[SENSOR] DP --> S2[SENSOR] DP --> S3[SENSOR] DP --> S4[SENSOR] S1 --> DP S2 --> DP S3 --> DP S4 --> DP DP --> D[DISPLAY] DP --> A[AUDIBLE ALARM] </pre>			

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

TYRE PRESSURE WARNING SYSTEM

This invention relates to a tyre pressure warning system of the type which can be used on vehicles to advise the driver if the pressure in any of the tyres on the 5 wheels of the vehicle changes from a predetermined value by more than a given amount. Typically, it will be used to warn the driver of deflation of the tyre.

The present invention is an improvement on a system known as TireMate which has been sold in the United 10 States. This consists of a pressure sensor/transmitter, which replaces the dust cap on the outer end of a tyre valve. The sensor/transmitter is a mechanical pressure sensor. It is preset with a reference pressure, the ideal pressure for the tyre on which it is to be mounted, and a 15 triggering pressure. If the pressure in the tyre falls to the triggering pressure the sensor/transmitter transmits only its identity to a control unit which then indicates to the driver that a fault has occurred on that. Thus, when the pressure in the tyre becomes too low the driver 20 will be warned of this and will have the option of doing something about it. The sensor/transmitter unit transmits continuously until the battery powering it is discharged.

One problem with this system is that 25 sensor/transmitter units have to be preset with desired and triggering pressures. This is normally done at manufacture and means that units cannot easily be switched to other vehicles with tyres that run at different pressures.

The present applicants have appreciated that the 30 driver of the vehicle does not need to be constantly reminded of the pressure in the tyre and, thus, does not

need repeated transmission of pressure data from the sensor to the data processing and display unit. All that the driver requires is a warning of some kind when the pressure in the tyre differs from the desired pressure by 5 more than a predetermined amount. It is not necessary to transmit the exact pressure data. Thus, a preferred embodiment of the invention provides a system in which the sensor/transmitter only transmits an over or under pressure signal to the data processing and display unit 10 when the pressure in the tyre differs from the desired pressure by more than a predetermined amount.

Another problem with the prior art system arises from the fact that the temperature of tyres on motor vehicles can vary considerably. The temperature of tyres on a 15 vehicle which has been driven for some time will be significantly higher than the temperature at rest and this will cause a significant increase in pressure. Also, in some environments, e.g., the desert, temperatures between night time and day time vary by a considerable amount 20 thereby leading to variations in pressure entirely dependent on temperature.

In accordance with a further embodiment of the present invention, a sensor/transmitter device is provided to replace a standard dust cap. A thermistor is provided 25 and is exposed to the gas filling the tyre and thus is sensitive to temperature changes in the gas. A software driven microprocessor receives a signal from the thermistor and is thus able to take account of temperature changes in determining whether or not there has been any 30 increase or decrease in the real pressure in the tyre.

The invention is defined in the appended claims to which reference should now be made.

Preferred embodiments of the invention will now be described in detail by way of example with reference to the accompanying drawings in which:

5 Figure 1 shows a schematic diagram of a system embodying the invention;

Figure 2 shows a schematic diagram of a sensor embodying the invention; and

10 Figure 3 shows a schematic diagram of a further embodiment of the invention for use on vehicles with detachable trailers.

In Figure 1, there are shown four sensor units 2 each coupled to a respective transmitter 4. These units are included in a unit which screws onto a tyre valve and replaces its dust cap. On a four-wheel vehicle the system 15 would be as shown in Figure 1 with four sensor/transmitter units, one attached to the dust cap on each wheel. It can however be used on two wheel vehicles or vehicles with more than four tyres or wheels.

The pressure transducers used in the 20 sensor/transmitter units are electronic sensors under microprocessor control. They are controlled to transmit to a control unit an identification code when they are installed on a tyre. They are also controlled to measure and record the pressure they first encounter when they are 25 installed on a tyre. This is stored in memory and is used for comparison with the tyre pressure during use to determine whether the tyre pressure has changed by more than a predetermined amount. Preferably this change is monitored as a percentage of the first encountered 30 pressure, e.g. 15%. The transducers used preferably have a range from 0.5 to 10 bar and this enables the same

- 4 -

sensor/transmitter units to be used on a wide range of vehicles.

A data processing unit 6 is provided in the cab of the vehicle in a position where it can be viewed by the driver. This data processing unit is coupled to a receiver 8 which receives signals transmitted by the transmitters 4. It is also coupled to a display 10 which is used to display tyre deflation/inflation warning information to the driver. The display 10 is preferably an alphanumeric display of, for example, the liquid crystal type. Thus it can provide instructions and information to the user.

The sensors are coupled to the microprocessor which monitors the output signal from its respective sensor and, if the signal alters in such a way as to indicate that the pressure in the respective tyre has changed from the first encountered pressure by more than the predetermined amount, the processor controls the transmitter to transmit a warning signal to the data processing unit 6 which receives it by means of receiver 8. This warning signal comprises an identification signal identifying the sensor. In this particular embodiment the identification signal is a 16-bit coded signal which enables over 65,000 different sensor identification codes to be used. This makes the chance of a signal from a sensor with a corresponding ID on another vehicle being sent to the data processing unit 6 very remote. Previous systems such as the TireMate system included the possibility of only 14 individual settings for sensor identification codes.

The sensor/transmitter units are arranged to transmit every 24 hours an OK signal to the data processing unit 6 if no fault condition is detected within a 24 hour period.

The purpose of this signal is to ensure that the data processing unit has information indicating that all sensor/transmitter units on a vehicle are working. Thus, if a fault develops on a unit or its battery runs out of power, no OK signal will be sent to the data processing unit 6 and this can then indicate to the driver via the display 10 that there is a problem with the sensor/transmitter unit on a particular wheel of the vehicle. Furthermore, the sensor/transmitter is preferably arranged to detect faults with the sensor and to transmit to the control unit a sensor fault signal to the driver indicating that a problem has occurred with a particular sensor.

The sensor units are designed to determine the pressure of the tyres on which they are installed, store this pressure in memory and, subsequently, trigger a fault condition transmission when the pressure change within the tyre is, for example, plus or minus 15% from the pressure originally measured and stored. Thus, there is no requirement for triggering of fault condition signals at predetermined pressures.

When a fault condition is detected the sensor/transmitter in this embodiment sends the fault signal repeatedly over a period of 30 seconds. The transmission is then terminated to save the battery life of the sensor. Thereafter, the alarm transmission is repeated every 15 minutes for a 30 second period. To rectify a fault the sensor/transmitter unit is removed from the tyre by unscrewing the dust cap. Exposure of the transducer to atmospheric pressure causes the sensor to reset and causes the fault transmission to cease. These timings can of course be varied as desired.

Another embodiment of a sensor/transmitter unit is shown in Figure 2. In this, it can be seen that the sensor comprises a sensor unit 2 (preferably an electronic sensor) which is responsive to the tyre pressure and a thermistor 12 (temperature dependent resistor) which changes resistance as the temperature in the tyre changes. The processor 14 monitors the signal from the sensor 2 and from the thermistor 12. From this, it is able to determine what temperature increase or decrease in the tyre has occurred and thus is able to compensate the signal from the sensor for this temperature increase/decrease. This avoids the sending of a spurious fault condition signal when pressure increases or decreases purely because of a large change in temperature. It ensures that fault transmissions only occur when there is some other cause for an increase/decrease in pressure.

The data processing and display unit is used to record the identities of sensor/transmitter units installed on a vehicle. This information is stored in memory. The control unit prompts a person installing the sensor/transmitter units to install the units on each tyre in turn. Prompting is done via the display 10 where an indication of the tyre on which the next unit to be installed is made. When each unit is installed, the initial exposure to the tyre pressure causes it to transmit its identification code to the control unit. Thus the control unit is able to record the identification code for the unit installed on each tyre.

The data processing unit validates any transmission received by ensuring that it is repeated several times in the same format. This it does during the transmission period of 30 seconds from a fault condition being detected

and transmission of that commencing. This is done to exclude spurious transmissions and to ensure that the identity code received relates to a sensor which has previously been recorded as being installed on the 5 particular vehicle.

Details of any fault transmission which are received by the data processing and display unit are stored in memory together with the tyre position concerned and the time at which that observation was made. Thus, if the 10 fault occurs while the vehicle is not being driven it is stored and will be provided to the driver via the display and an audible alarm 11 when the vehicle is next switched on. Similarly, the failure of any sensor to transmit an 15 OK signal will be stored in memory together with the tyre position concerned so that the driver will be alerted of the failure of that sensor/transmitter to operate correctly.

In many commercial vehicles, separate tractor and trailer units are used, particularly in the road haulage 20 industry. Trailers may be disconnected from tractors for a considerable period of time and may in fact be reconnected to different tractors. If a tyre deflation should take place whilst a trailer is disconnected, the tractor unit with the standard data processing and display 25 unit will not be in the proximity and, thus, details of the failure will not be stored. To overcome this, a separate data transceiver unit is provided on a trailer. This is illustrated in Figure 3. In this, a data transceiver unit 16 is provided mounted on a trailer and 30 is coupled to a receiver 18. This receives signals from sensors/transmitters mounted on the wheels of the trailer. It includes a memory which stores any fault condition

signals and the OK signals received while a trailer is not connected to a tractor. A separate power supply is included in the data transceiver unit 16 and this is preferably a rechargeable battery which is recharged when the transceiver is connected to the power supply of a tractor.

On the tractor is provided a normal data processing unit 6 and display 10 of the type shown in Figure 1. This is coupled to a receiver 8 which receives signals from sensor/transmitters mounted on the wheels of the tractor unit.

A connector 20 is used to couple the data processing unit to the data transceiver when the tractor unit is coupled to the trailer for power supply. On initial coupling, all data stored by the data transceiver is downloaded to the tractor unit. This comprises the identities and locations of the sensors mounted on the trailer, whether or not any fault condition has occurred on any of these, and details of whether the OK signals required every 24 hours have been received.

The connection 20 between the data transceiver 16 and the data processing unit 6 need not be a hard-wired connection. The data transceiver could be provided with a transmitter 22 which, when a tractor is linked to the trailer, could be organised to transmit all the relevant information to a receiver 24 on the data processing unit 6. Thereafter, signals from the trailer sensor transmitters could be received either by the data transceiver 16 or by the data processing unit 6.

Using this arrangement enables tractors and trailers to be interchanged without having to reprogramme the tyre pressure warning system.

CLAIMS

1. A tyre pressure monitor system for a vehicle comprising a plurality of sensor/transmitter units for mounting on each tyre of the vehicle and a receiver/control unit;
5 each sensor/transmitter unit comprising pressure sensor means, processing means for comparing a current pressure signal from the sensor means with a pressure signal stored in a memory means and corresponding to the pressure first encountered on installation of the sensor/transmitter unit and means for transmitting a fault signal when the current pressure signal differs from the stored pressure signal by more than a predetermined amount;
- 15 is the receiver/control unit comprising means for receiving signals from sensor/transmitter units and means for indicating that a fault condition has occurred in one of the tyre pressures in response to a received fault signal from a sensor/transmitter unit.
- 20 2. A tyre pressure monitoring system according to claim 1 in which the memory means in each sensor/transmitter unit stores an identification code associated with that unit and the sensor/transmitter unit is operable to transmit this identification code with a fault signal.
- 25 3. A tyre pressure monitoring system according to claim 2 in which each sensor/transmitter unit is controlled to transmit its identification code to the

- 10 -

control unit when it is first installed on a tyre and stores its first encountered pressure signal.

4. A tyre pressure monitoring system according to claim 3 in which the control unit prompts a user of the 5 system to install sensor/transmitter units on each tyre in turn.

5. A tyre pressure monitoring system according to claim 1, 2, 3, or 4 in which each sensor/transmitter 10 includes means responsive to temperature of the tyre with which it is associated and means for compensating the pressure signal in dependence on detected temperature variations prior to comparison with the desired pressure signal.

6. A tyre pressure monitoring system for a vehicle 15 comprising a plurality of sensor/transmitter units for mounting on each tyre of the vehicle and a receiver/control unit;

each sensor/transmitter unit comprising 20 pressure sensor means for monitoring tyre pressure, temperature sensitive means responsive to temperature of the tyre with which it is associated, and means for transmitting data derived from the pressure sensor means and the temperature sensitive means;

the control unit comprising means for receiving 25 data from the sensor/transmitter units and means for indicating that a fault condition has occurred in one of the tyre pressures.

- 11 -

7. A sensor/transmitter unit for monitoring tyre pressure comprising a pressure sensor means and a temperature sensitive means responsive to tyre temperature and means for transmitting data derived from the pressure sensor means and the temperature sensitive means.

1 / 2

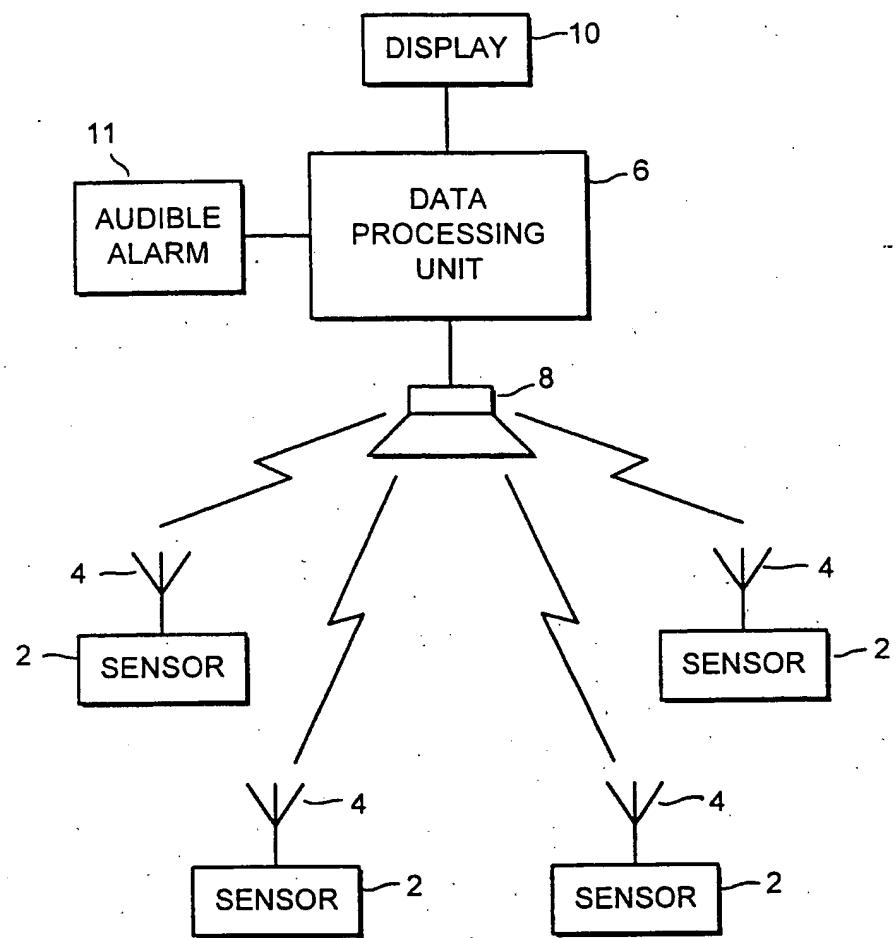


FIG. 1

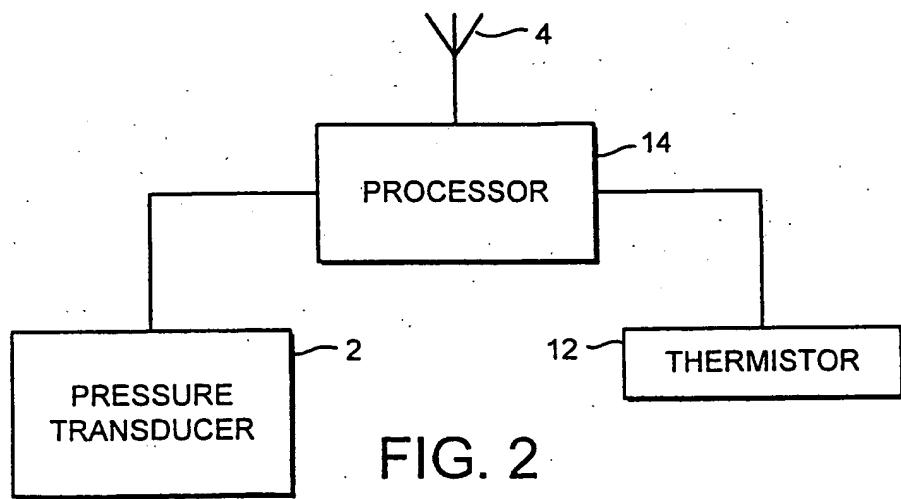
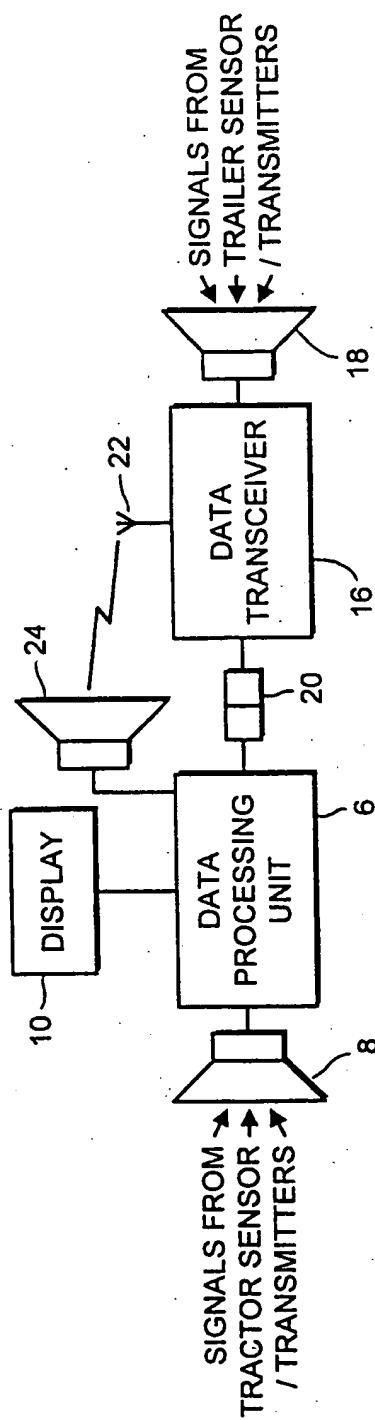


FIG. 2



3
E/G

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00358

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B60C23/04

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 06747 A (OTTER CONTROLS LTD) 7 March 1996 see abstract see page 3, line 19 - page 4, line 14	6,7
Y	DE 43 03 591 A (ACHTERHOLT RAINER) 11 August 1994 see the whole document	1-5
Y	WO 94 20317 A (SCHRADER AUTOMOTIVE INC) 15 September 1994 see page 5, line 21 - page 8, line 6 see page 10, line 20 - page 11, line 23	1-5
A	DE 195 22 486 A (DUERRWAECHTER E DR DODUCO) 9 January 1997 see the whole document	1

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

17 July 1998

Date of mailing of the international search report

23/07/1998

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Blandin, B

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 98/00358

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
WO 9606747	A 07-03-1996	AU 3392695 A	CA 2197447 A	EP 0778803 A	JP 10504783 T
					22-03-1996 07-03-1996 18-06-1997 12-05-1998
DE 4303591	A 11-08-1994	WO 9418017 A			18-08-1994
WO 9420317	A 15-09-1994	AU 673516 B	AU 3791493 A	BR 9307763 A	EP 0687225 A
					24-10-1995 20-12-1995
				JP 8505939 T	US 5600301 A
					25-06-1996 04-02-1997
DE 19522486	A 09-01-1997	WO 9700784 A	EP 0833756 A		09-01-1997 08-04-1998